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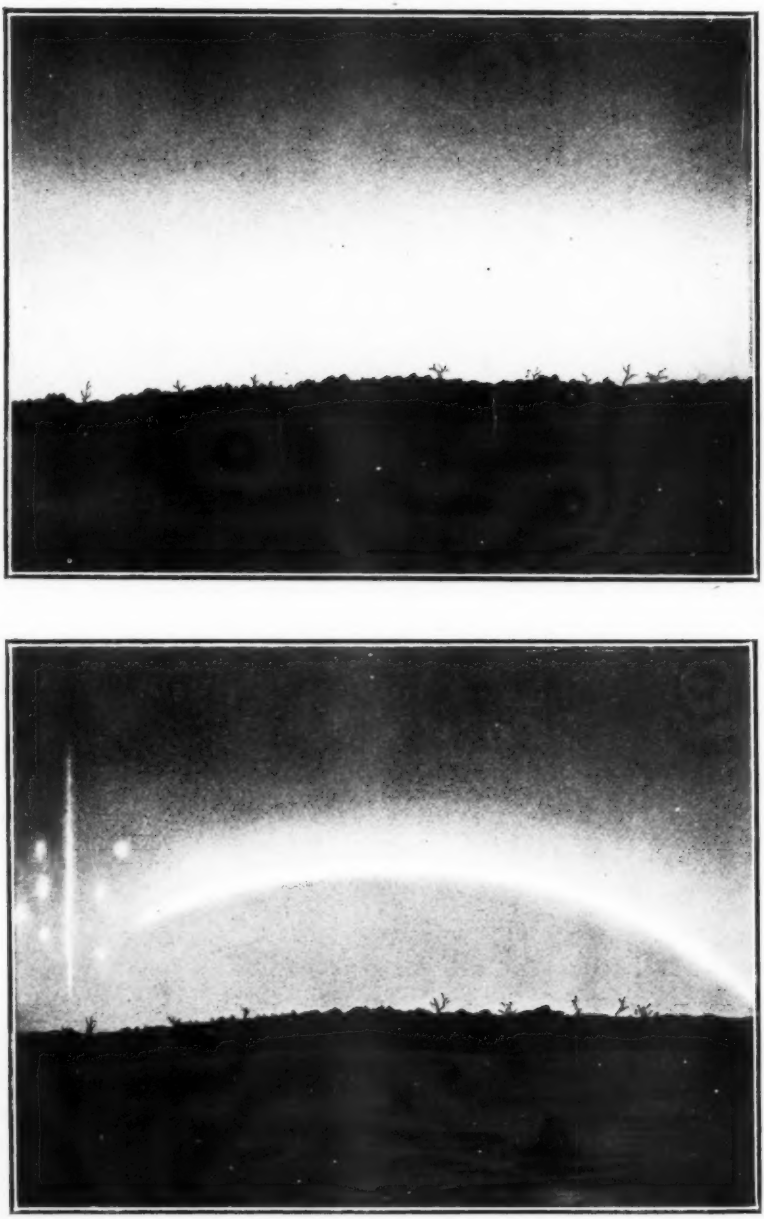
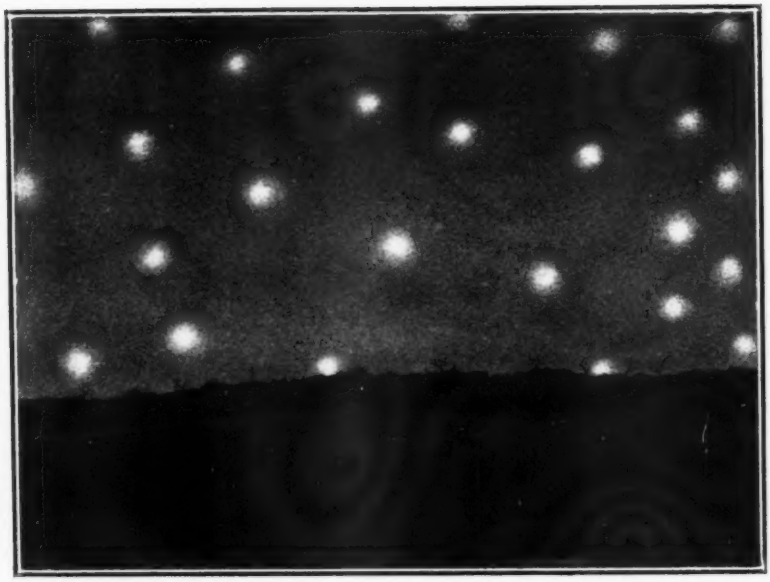


AURORAL DISPLAY OF AUGUST 21, 1917

Journal of the Royal Astronomical Society of Canada, 1917

PLATE XVI.



INSTANTANEOUS APPEARANCE OF AURORAL DISPLAY OF AUGUST 21, 1917

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AURORA BOREALIS; DISPLAY OF AUGUST 21, 1917

BY A. STEADWORTHY

ON the night of Tuesday, August 21st last, there was witnessed at our camp, which was at Moore Lake, east of Algonquin Park Station, one of the most vivid and brilliant auroras that it has been my lot to see. The latitude of the camp was about 45° 25′ N. and longitude 78° W. We were in a clearing to the northeast of the lake, and hence had a fairly unobstructed view of the sky. Being but a few days after new moon, there was no moonlight at the time, and the sky was cloudless, with the stars shining brightly even through all the auroral display about to be described.

The aurora first attracted attention at about 9.30 p.m., when it appeared as a segmental soft white cloud resting upon the horizon between the east and north points, as shown in Plate XV., upper part. Shortly afterwards vertical streamers ascended from it in the east and north. The diffused light gathered into an arch, Plate XV., lower part, one end of which extended to the horizon or rather behind the trees in the vicinity of sun-rise, while the other end terminated not at the horizon but possibly at an elevation of 15° and to the east of north. At the

westerly end there were numerous short streamers showing little agitation. However, within about five minutes the arch disappeared and resolved itself into rapidly moving streamers which presently broke up into individual patches and which set up an extraordinarily merry dance, starting from the horizon and running towards and beyond the zenith. The rapidity of motion reminded one of that of lightning. The activity was almost wholly confined between the east point and a little west of north, as shown in Plate XVI., which is a very good representation of an instantaneous appearance.

By 10.25 p.m. the activity materially diminished and no further observations were made. To indicate the brightness of the sky consequent on the aurora, it may be said that ordinarily at night we made use of a lantern to obtain water at a near-by well, but on this night the lantern was unnecessary. Unfortunately the writer forgot to test by means of some obstruction whether the light was sufficiently strong to cast a well-marked shadow.

It may be observed that the magnetic declination here is about 8° west, and that usually the auroral display is more pronounced in the magnetic meridian, which is generally also the centre of any arches that are formed; in the present instance this was far from being the case.

Störmer's observations have shown that the vast majority of auroral displays occur at an altitude of 100 kilometers, so that the present brilliant display was probably seen over a radius of, at least, 680 miles, or say over an area of one and a half million square miles.

It is to be hoped that reports from other places* will be received, as well as of the behavior of self-recording magnetic instruments during the hour 9.30 to 10.30 p.m., eastern standard time.

DOMINION OBSERVATORY,
OTTAWA, CANADA.
August 29, 1917

*See September number, p. 315; also pages 391 and 400 this issue.—ED.

THE DETERMINATION OF THE DATE OF EASTER

By J. W. Campbell

THE purpose of this paper is to explain the method of, and to give a means for, the determination of the date of Easter. The present convention for its determination has been in use since its institution by the Council of Nice in 325 A.D., and if the civil calendar had undergone no changes since that time then a simple means could be developed which would give the date of Easter for any year subsequent to that date. But the civil calendar has reached its present form by a process of evolution, rules for corrections having been added from time to time which more accurate observations have shown to be necessary in order to prevent the civil year becoming secularly displaced from the astronomical year. The calendar reached its present form at the time of its reformation in 1582, and the method of using intercalary days then introduced is sufficient to keep it correct for thousands of years. To avoid the additional complexity of the effect of a change in the civil calendar, the method by which Easter can be determined for any year subsequent to 1582 is given, and this is the period in which we are, perhaps, most interested. For the dates of Easter preceding that date the reader is referred to a full discussion to be found in the *Encyclopædia Britannica*.

In determining a date such as Easter, which is fixed by the phases of the moon, we are confronted by the difficulty that a complete lunation does not consist of a whole number of days. Moreover, while a date includes a whole day, a phase of the moon occupies only an instant of time and so it is obvious that ambiguities might arise in fixing a date for different parts of the world according to the phases of the moon. To facilitate the determination of such dates, therefore, a fictitious moon called

the *ecclesiastical moon* has been introduced whose lunations consist always of whole numbers of days, and of which the full moon has been defined as occurring on a certain date instead of at an instant of time. Ecclesiastical full moons may differ by as much as two days from the true full moons, but the variation is not secular and with the present adopted system the two moons will remain coincident with the same degree of approximation for many thousands of years.

In dividing the year into ecclesiastical moons it has been agreed that every common year shall consist of twelve moons of 29 and 30 days alternately, the first moon completed in the year to consist of 29 days. In a leap year the same rule applies except that the moon in which February 29 occurs contains an extra day. Thus, in every year there are twelve ecclesiastical moons and a remainder of 11 days. The manner of disposing of these remainders of 11 days is suggested by the equations

$$365 \times 19 = 6935,$$
$$[(29 + 30)\,6]\,19 + 30 \times 6 + 29 = 6935.$$

For in 19 years the remainders amount to $11 \times 19 = 209$ days, which is sufficient to form six moons of 30 days each and one of 29 days. If they were thus accounted for, then, in view of the manner of disposing of the leap year intercalary days, we would have 235 ecclesiastical lunations exactly equal to 19 years in length. This harmonises precisely with the Greek astronomer Meton's supposition that 235 true lunations occur in 19 years. That supposition, though not exactly, is very approximately correct, and the period of 19 years has become known as the Metonic cycle. To prevent the displacement between corresponding ecclesiastical and true lunations from accumulating, the above method of disposing of the remainders of 11 days is corrected by the lunar and solar equations as will be shown later.

By the Council of Nice in 325 A.D. Easter was defined as being *the first Sunday after the first full moon which falls on or after the vernal equinox*. The vernal equinox was fixed invari-

ably at March 21, and full moon was defined as the fourteenth day of the ecclesiastical moon, the full moon preceding Easter being called the *paschal full moon*. If the paschal full moon falls on a Sunday, then the following Sunday is to be Easter. Thus the determination of Easter does not depend on the observed or computed time of the true vernal equinox which varies slightly from year to year, nor on the computed time of a true full moon. Thus, the problem is much simplified, ambiguities are eliminated, and the date determined is the same for all parts of the world.

According to the definition just given, it is clear that if we know the age of the moon on January 1 for any year, and also the date of the first Sunday of the year, we can compute the date of Easter. The first of these quantities is called the *epact* (E), and the second the *Dominical letter* or Sunday letter. The epact ranges from 1 to 30 and the Dominical letter is given by one of the letters A to G, A meaning that the first Sunday of the year is on January 1, C meaning that it is on January 3, and so on.

The determination of the date of Easter when the epact and Dominical letter are known may be illustrated by an example. For 1918 we have E = 17 and the dominical letter F. Thus the moon (ecclesiastical) will be 17 days old on January 1 next, and therefore, on March 21 which is 79 days later it will be 79 days older. Rejecting 29 days, 30 days, and 29 days successively for complete lunations we have that the moon will be 8 days old on March 21.* The paschal full moon will, therefore, occur 6 days later, that is, on March 27. Again, since the Dominical letter is F, January 6 is a Sunday. Now March 27 is 80 days, or 11 weeks and 3 days, later, and, therefore, it will fall on a Wednes-

*In general the age of the moon on March 21 is E + 20. For in any common year its age is E + 79 − (29 + 30) = E + 20, and in any leap year this is also its age, for although March 21 is in that case 80 days later than January 1, yet the lunation rejected, which includes February 29, contains an extra day. Whenever E + 20 exceeds 29, however, then another 29 must be rejected and the remainder taken.

day. The following Sunday will be four days later and by the definition will be Easter. Thus Easter will occur on March 31 next year.

The next question is, how to find the epact and Dominical letter for any required year when they are known for a given epoch. This requires the consideration of another quantity, the Golden Number of the year (G), which is the number of the year in the Metonic cycle in which it occurs. Obviously G ranges from 1 to 19, and it is further obvious that it increases by unity for each succeeding year. As often as it exceeds 19, 19 is rejected and the remainder taken. Now, since every year consists of twelve ecclesiastical moons with a surplus of 11 days, it follows that the moon will be 11 days older on the first of any given year that it was on the first of the year preceding. For this reason the epact for any year may be obtained by adding 11 to the epact of the preceding year. During a Metonic cycle these elevens make up six moons of 30 days each and one moon of 29 days. But instead of rejecting 30 from the epact six times and then 29 once, it is agreed to always reject thirties from the epact and to compensate by augmenting the epact by 12 instead of 11 whenever a new cycle is begun. For several reasons this method is preferable.

Lastly, since each common year consists of fifty-two weeks and one day, the effect of a common year is to cause the Dominical letter to retrograde one letter for the next year. Likewise, since a leap year has an excess of two days over an integral number of weeks, the effect of a leap year is to cause the Dominical letter of the year following to differ by a retrogression of two letters. Thus, the Dominical letter of 1916 was B, and 1916 being a leap year the Dominical letter of 1917 was retrograded two places from that of 1916 and consequently was G. Again, 1917 being a common year the Dominical letter will retrograde one place for 1918 and so it will be F for next year.

To sum up we have the following rules:

"(1) The Golden Number increases by unity each year.

As often as the result exceeds 19, 19 is rejected and the remainder taken.

(2) The epact increases by 11 each year, except when a new Metonic cycle begins in which case it increases by 12. As often as the result exceeds 30, 30 is rejected and the remainder taken.

(3) The Dominical letter retrogrades one letter at the end of each common year and two letters at the end of each leap year."

These rules would be adequate for all time if the supposition of Meton were correct, but since that supposition is not exactly true two corrections have to be applied.

First, there is the *lunar equation*. In assuming the year to consist of 365·25 days, 19 years exceed 235 lunations of 29·5306 days each by 1 hour 29 minutes and so the epact is too small. The error amounts to a day in a little over 300 years. This error is corrected by adding 1 to the epact at intervals of 300 years for eight times, then skipping 400 years and again adding 1 to the epact at intervals of 300 years, thus making an increase of 8 days in 2500 years. On account of certain conditions at the time of the reformation of the calendar it was deemed best to have the lunar equation occur at 1800, 2100, 2400, ..., 3900, 4300, 4600, ...

Secondly, there is the *solar equation*. When we assume the year to consist of 365·25 days instead of 365·2422 days the error is approximately 3 days every 400 years and it has the effect of making the epact too great. The error is corrected by reducing the epact by unity at the end of each century year not exactly divisible by 400.

Hence, *the lunar equation occurs at 1800, 2100, 2400, ..., 3900, 4300, ... and is positive; the solar equation occurs at 1700, 1800, 1900, 2100, ... and is negative.*

We are now able to find the epact and Dominical letter of any year when these quantities are known for a given year. At the time of the reformation of the calendar in 1582 the Golden Number was 6. A Metonic cycle had, therefore, started five

years previously, that is, in 1577. The epact for 1582 was 26, and so the epact for any succeeding year, Y, is given by the formula

$$E = \left(26 + 11\,(Y - 1582) + \left(\frac{Y - 1577}{19}\right)_w + Nm - Ns\right)_r,$$

where Nm and Ns denote respectively the number of times the lunar and solar equations have occurred between 1582 and Y, the subscript w means that the whole number part of the quotient is to be taken, and the subscript r means the remainder is to be taken after the division has been carried out. That this formula gives the epact follows from the definition of the epact and from the way it has been shown to vary. For $Y - 1582$ is the number of years since 1582 and is, therefore, the number of elevens that must be added to the epact of 1582, and

$$\left(\frac{Y - 1577}{19}\right)_w$$

is the number of Metonic cycles that have been completed since 1582 and is, therefore, the number of times the epact must be increased by an extra unit.

This formula for E is rather cumbersome and may be simplified. The year 1577 was the beginning of a Metonic cycle and, therefore, 1596 was the beginning of the next cycle. The epact for 1596 as given by reduction of the formula is 1, and, hence, the epact for any year succeeding 1596 is given by

$$E = \left(1 + 11\,(Y - 1596) + \left(\frac{Y - 1596}{19}\right)_w + Nm - Ns\right)_r.$$

But since only the remainder is taken, it is obvious that multiples of 30 may be removed from the numerator of the right-hand expression without affecting E. Now $11 \times 19 + 1 = 210 =$ a multiple of 30. Therefore, if we remove all multiples of 19 from the factor $Y - 1596$, together with the term

$$\left(\frac{Y - 1596}{19}\right)_w$$

it is clear that we shall be dropping only multiples of 30 and, therefore, E will be unchanged. But when all multiples of 19 are rejected from $Y - 1596$ we shall have

$$\left(\frac{Y - 1596}{19}\right)_r$$

left, and since 1596 is the first year of a cycle this expression gives the Golden Number decreased by unity, that is, $G - 1$. Therefore, E is given in terms of G by the formula

$$E = \left(1 + \frac{11\,(G - 1) + Nm - Ns}{30}\right)_r \quad (1).$$

This formula is readily applied. G is given by the equation

$$G = \left(\frac{Y + 1}{19}\right)_r, \text{ for } G - 1 = \left(\frac{Y - 1596}{19}\right)_r = \left(\frac{Y}{19}\right)_r$$

and, therefore,

$$G = \left(\frac{Y + 1}{19}\right)_r.$$

Formulæ can be developed for Nm and Ns but they are complicated, and as these quantities are small except for very distant dates they can readily be obtained by counting.

Again, the Dominical letter for 1583, the year following the reformation, was B. Then the formula

$$(Y - 1583) + \left(\frac{Y - 1581}{4}\right)_w + \left(\frac{Y - 1601}{400}\right)_w - \left(\frac{Y - 1601}{100}\right)_w$$

gives the number of letters the Dominical letter has retrograded in its cyclic interchange on the letters A B C D E F G from 1583 to Y. For 1580 was the last leap year preceding 1583, and hence

$$\left(\frac{Y - 1581}{4}\right)_w$$

is the number of times the Dominical letter would retrograde an extra place due to the leap year intercalary days if all century years were leap years. But since only those century years exactly divisible by 400 are leap years it follows that too many extra retrogressions have been made. It is clear that the last term eliminates the effect of all century years and that the second

last term re-inserts those century years which are leap years. The whole expression, therefore, represents the total number of years from 1583 to Y, together with the total number of leap years not including Y when Y is a leap year, and, hence it is the number of places the Dominical letter has retrograded. But since every seven successive retrogressions bring the letter back to B, multiples of seven may be rejected, and the effective number of retrogressions is given by the formula*

$$\left(\frac{(Y-1583) + \left(\frac{Y-1581}{4}\right)_{a'} + \left(\frac{Y-1601}{400}\right)_{a'} - \left(\frac{Y-1601}{100}\right)_{a'}}{7} \right)_r \quad (2).$$

Formula (1) gives the epact for the year Y and by formula (2) the Dominical letter is found. Thence the date of Easter is determined as previously shown. Another example is here given to illustrate.

Problem.—Required the date of Easter for 1960.

(1) *The epact and Dominical letter.*

The Golden Number for 1960 is

$$\left(\frac{1960 + 1}{19} \right)_r = 4,$$

and by counting we get $Nm = 1$, $Ns = 3$. Then by formula (1) we have

$$E = \left(\frac{1 + 11\,(4 - 1) + 1 - 3}{30} \right)_r = 2.$$

Again on putting $Y = 1960$ in formula (2), and reducing, the number of retrogressions is 6, and, therefore, the Dominical letter is C.

(2) *The date of the paschal full moon.*

The age of the moon on March 21 is $E + 20 = 22$ days, as before shown. Since there are 29 days in the third lunation of

* It is customary to give the Dominical letter of a leap year as a double letter, but I have here restricted the Dominical letter to represent the date of the first Sunday of the year. When taken strictly in this sense its value is unique.

the year, the next full moon will occur 7 + 14 = 21 days after March 21, which is April 11. This is the date of the paschal full moon.

(3) Since the Dominical letter is C, then January 3 is a Sunday. April 11 is 99 days or 14 weeks and 1 day later and it, therefore, occurs on a Monday. The Sunday following is six days later, that is, April 17. This is, therefore, the date of Easter for 1960.

WESLEY COLLEGE,
WINNIPEG.

SUMMER OBSERVATIONS

By A. R. Hassard

OFTEN when in the country I wonder that so few telescopes for the purpose of observing the heavens are to be found. In the past fifteen years I have travelled tens of thousands of miles over the Province of Ontario, and one would imagine that even opera glasses were diamonds of inestimable value, so difficult is it to find a pair. A collapsing telescope is a remarkable rarity, while a two-inch achromatic glass with a racking movement for focussing is almost unknown. With so many periodicals containing short and simple articles describing how telescopes may be constructed with a small amount of labor and at a most trifling expenditure, it is strange that thousands of these articles are not to be found in homes which to-day boast of morning newspapers, rural mail deliveries daily, and the luxuries of the great centres of population brought right home to their doors. I have in my possession a telescope that will easily magnify the moon a diameter of 300 times, and which was constructed by me in a few hours' time and at a cost of not over four or five dollars. The same instrument if bought of a telescope dealer would have cost almost as many hundreds of dollars as it cost me dollars.

With this instrument, as well as with some others in my possession, and also without aid of a telescope at all, I did some observing during the past summer. While I always think the winter heavens are more resplendent with stellar objects of interest to the casual observer, the summer, with its absence of frost-bitten fingers and tingling ears and shivering body, has astronomical advantages that are quite foreign to the winter. Therefore, I usually devote many a stray hour to observing during the nights of the summer.

During the summer past, and principally during the month of July, I spent considerable time in observing sun spots, which were particularly large and exceedingly numerous almost the

whole of the summer months. At present I am following with the telescope a pair of sunspots which, with a magnification of about 80 diameters, resembled very much (except, of course, in color) the twin stars Castor and Pollux, and with that magnification were just about as far apart as those two stars appear nightly to the naked eye. When these spots first appeared near the circumference of the sun, they looked almost circular, but they were not as distinct as they later became. Some mornings afterwards they were observed to be near the central part of the sun's disc, when they were at right angles to the line of vision, and, of course, were very distinctly seen in detail. Then they appeared to vary considerable from true circles, and were very black when observed through a blue-colored sun-glass, while around them were very wide borders of a distinctly greyish color, exactly of the same shape in circumference as the black spots themselves. These greyish borders are the penumbræ of the sunspots. During the journey of these two large spots across its surface, caused, of course, by the rotation of the sun on its axis, they did not seem to change their position in relation to one another or in relation to the poles of the sun. But I did notice another change that may be worth mentioning. One morning last week when recurring to my observations, after an interruption of two days, I saw the two original large spots, but there were a number of other spots which previously had been invisible, and which did not owe their appearance to the revolution of the sun on its axis, but rather to the fact that they had made a sudden outburst in some mysterious manner. I do not recal learning that anyone ever did actually witness an outbursting of these solar spots, and yet they must make their appearance with some degree of suddenness,. Nor does it seem that the phenomenon suggested would be difficult to find transpiring. For at a time such as the present, when solar activity is very noticeable, it should be comparatively easy to watch the sun's surface near where changes are most to be expected, and witness the marvellous manifestation of the sun in its agony, and a new upheaval or sun-sundering, as a hitherto

unknown sun-spot burst into its physical new birth. When later, a few days ago, I looked at the sun, the two large sun-spots, previously mentioned were approaching the sun's western circumference, although a considerable distance from it. Since then the weather has been unfavorable for observations at the times I have had at my disposal. I have not yet had an opportunity to follow a sun-spot or group of sun-spots during a complete rotation of the sun, but hope to be able to do so at some future time. The sun-spots during the summer past were very numerous; as many as seven or eight different large spots or groups being visible at the one time, and scarcely on any occasion was the sun's surface free from these markings. With the great sun-spot activity there was manifest a lowness of temperature that has been quite unusual in these parts. Whether there is any connection between the earth's temperature and solar action or not has not yet been determined, although suggestions have been ventured in the negative. Further observations may furnish an answer to the question.

Many displays of the Aurora Borealis were seen during the summer. Frequently, while motoring from Toronto to Lake Simcoe in the evenings during the month of August I was able to observe these, as during the greater part of the way I was facing north. The displays were magnificent, the luminous, yet mysterious, tongues of light flashing zenithward with silent but spectacular splendor, until frequently the whole northern heavens were one vast burst of auroral light. My sister told me that on several occasions during August she had observed wonderful displays of these from the verandah of our cottage on the shores of Lake Simcoe.

Venus has been very conspicuous in the western heavens during the past months. On the 16th September I saw it at 6 o'clock in the evening, while returning from North Toronto Aviation Camp, as the star hung quite low in the south western heavens. I never remember to have seen it more brilliant. It seemed like an electric light in the distance, so intensely bright did it appear in the cool clear air of the early evening.

On October 2nd I saw Mars and Saturn soon after they had been in conjunction. It was at 5 o'clock in the morning I saw them high in the eastern sky. They recalled to my mind the two stars Nu 1, and Nu 2, in the constellation of Scorpio. These stars are a rather widely separated naked eye double, seen easily all summer in the southern sky. Mars and Saturn at the time named were just about the distance apart of those two stars in Scorpio. Mars was distinctly ruddy in hue, and Saturn had its customary yellow tinge. They were both of apparently the same brightness and there did not seem to be any dissimilarity in their sizes. On October 9th I also saw Saturn and Mars again. By this time they had separated until they were almost as far asunder as Castor and Pollux.

On the 16th I viewed Jupiter through my 9½-inch reflector. I never remember having seen it stand out so plainly in the sky. At 11.30 p.m. the sky grew cloudy, and in a few minutes was almost completely covered over with white clouds. Feeling that observing was about over, I dismounted the instrument and placed the tube indoors. But within five minutes the clouds passed swiftly to the south-east, and every trace of them disappeared. Jupiter shone gloriously high up in the eastern heavens. I re-assembled the telescope, and viewed the planet still further. It was magnificently distinct. The four satellites were visible, and at least five lines or bands of markings on the ball of the planet. The narrowest was just to the south of, and touching, the equator. A much wider one was to the south of this dark band. The flattening of the poles of the planet was very noticeable. The planet in the 9½-inch reflector was very clear with all powers up to and including 315. Beyond that I can go to 430, but I find that with that power the lack of light is very marked, so that little advantage follows its use except for special purposes. I have a remarkable clear coating of silver on the large mirror, the best I think I ever obtained. The silvering was done nearly a year ago, but with some sheets of blotting paper placed within the cover of the mirror tarnishing is greatly prevented.

SOME PROBLEMS IN PHOTOGRAPHY

By A. Steadworthy

THE purpose of this paper is to explain one or two of the problems which photographers have to solve. The problem of successful photography is not quite so simple as might be inferred from a well-known advertising slogan adopted by some manufacturers a few years ago. The slogan read thus :— "You press the button ; we do the rest."

By this it was meant that any one could buy a camera or kodak with plates or films, and then go around, point the instrument at some object and press the button. When the films were all exposed all he had to do was to take the instrument to a photographer, leave it there and then in a few days call for the prints. That was all there was to it. How easy ! Nothing to it,—any man, woman or child could do it !

On the strength of this slogan thousands bought cameras and kodaks and began taking photographs, but how many good ones were made ? Things have changed since then and people have found out that there was more in taking photographs than merely "pressing the button." One has to learn how to do anything before he can make it a success.

TIMING OF EXPOSURES

One problem which confronts a photographer is that of judging the time required to expose a plate. There are, no doubt, different methods of judging the length of time required in order to obtain what I shall call a normal negative. By that I mean a negative which is neither over- nor under-exposed but has been exposed so that all details, shadows and high lights are distinct and clear, giving when printed a perfect print.

The judging of the exposure by the ground glass is to my mind the best of these methods. Take for example the case of the professional photographer. Any one familiar with cameras and kodaks knows that the instruments used by the professionals in their studios are provided with a ground glass at the back. The primary object of this ground glass is for focussing pur-

FIG. 1. PHOTOGRAPH TAKEN BY THE LIGHT OF AN ELECTRIC STREET LAMP. Exposure 10 minutes.

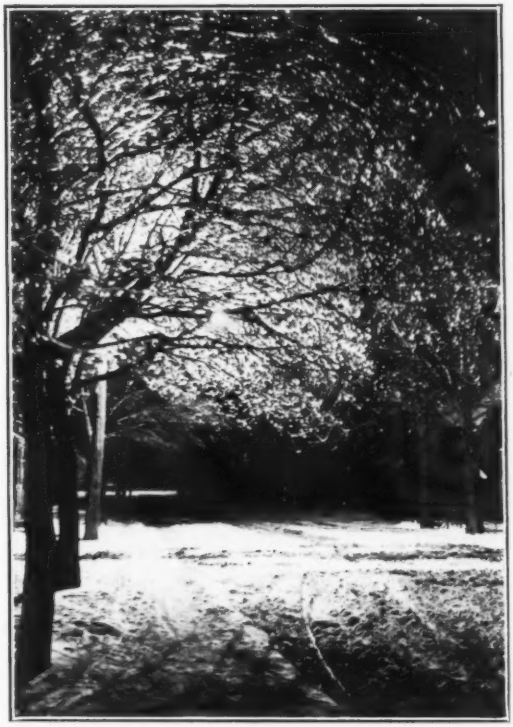


FIG. 2. WINTER SCENE ON BOLTON ST., OTTAWA.
Taken 9.30 p.m. Exposure 30 minutes.

poses, but it is also used for judging the proper length of time a plate should be exposed. A professional photographer, working as he does under continually changing conditions, has to use a method of some kind to enable him to expose a large number of plates in a day and have them all good enough to make good prints from.

Let us see now some of the conditions under which he is working. He may begin work on a bright sunny morning, but in an hour or so it may be cloudy or even raining. The light has obviously changed considerably. Then, again, he may be asked to photograph children three or four months old or people up to eighty or even ninety years of age. It can be seen that the conditions may vary considerably in one day.

Now, we must understand that if he wants to make his business a success financially he cannot expose too many plates on any one subject, but must use a certain limited number, or else it will take up too much of his profits,—plates being a very expensive item in photography. Therefore, he has to try to make good negatives without using too large a number of plates. It is here that he has to use a method which will enable him to do his work without great loss of time and material.

Now, suppose we have everything ready. The photographer has focussed his instrument on the subject, etc. Before exposing he generally takes a good look at the ground glass and decides immediately the length of time he will expose his plates. After doing so he is satisfied, provided the subject did not move, that he will have a good negative. So sure is he of his plates that nine times out of ten he does not develop them until late in the day. How does he decide so readily on his exposure?

I think that the best way to explain it is this. When the photographer looks at the ground glass he counts the time, generally in seconds, required for his eyes to grasp all the details of the subject he is going to photograph. Let me say that a good many do not actually count aloud but they do so mentally and often quite unconsciously. The time required for this may be only one second or it may be more, but whatever it is that

time is the time he will expose his plates. Photographers generally use fast plates in studios. What if he has a slow plate instead of a fast one? some may question. To this I would answer that the photographers generally know the speed of the different kinds of plates and if they do not they find out before using them, so the method can be used whether the plates are slow or fast. I think that any one familiar with photography will understand these few explanations readily.

I might say that if we use the ground glass, train our eyes to the amount of light reflected on it and practice on a few plates, we can soon find out that exposures can be judged to a great degree of certainty by the above method. I might also say that once one has acquired some experience with this method of timing he does not always need to count the whole time required but only part of the time; he may count five minutes and then decide whether he has to expose twenty or more minutes, etc.

Here I must call the attention of the reader to the fact that the method of timing mentioned above generally applies to exposures of over a second. When we have to expose in fractions of seconds it is then quite different owing to the short time required; in this case we generally depend more on our previous experience in taking what we call snap shots.

The accompanying plates give a few examples of pictures taken by this method of timing,

Plate XVII., Figure 1. This is a picture of a house taken at night by the light of an electric street lamp. It will be noticed that the lines are not perfectly square. This was due to my failure to use the swing back of the camera sufficiently. Having a limited distance from the house where I could place the camera it was necessary to tip it upwards so as to take in the whole house. Therefore, I had to use the swing back of the camera to keep the lines perfectly vertical. Although I did use it, it should have been swung further. With the thermometer 15 below zero and having very little light to focus by and having in view the illustration of the time exposure only, I was no doubt a little careless. I made only one exposure and it was quite satisfac-

PLATE XVIII.

MOONLIGHT PICTURE, TAKEN AT NIGHT FROM GATINEAU PT., P.Q., LOOKING TOWARDS ROCKCLIFFE PARK, OTTAWA.

FIG. 1. PHOTOGRAPH OF LIGHTNING
(Original size).

FIG. 2. PHOTOGRAPH OF TRAIN IN MOTION
(One half original size).

tory. The time of exposure was ten minutes on Eastman Isochromatic film with a Ross Stereographic lens, full opening about *f*/8.

Plate XVII., Figure 2. Winter view on Bolton St., Ottawa. This picture was taken at about 9.30 p.m. after a rain storm. The trees were covered with ice. The time exposure was 30 minutes on the same kind of film as before and with the same lens but with an opening of *f*/32.

Plate XVIII. A picture by moonlight. This photograph was taken at night from Gatineau Point, P.Q., looking towards Rockliffe Park, Ottawa. The time was judged by the strength of the light on the finder. The instrument was a five dollar box magazine camera for 4 x 5 plates. A Seed plate R was used. Here we can see that with proper manipulation we can make very interesting photographs with a comparatively cheap instrument.

From the above illustrations we can see quite plainly that the taking of night photographs is an easy matter, and I believe that there is something in them even more attractive than daylight photographs.

PHOTOGRAPHIC COMPOSITION

This composition was the most difficult piece of photographic work that I ever undertook, and is in itself, I believe, quite a problem for any photographer. The finished picture, shown in Plate XX., represents an express train going at full speed during a thunderstorm at night.

The actual taking of such an original photograph is obviously a practical impossibility for more than one reason. In the first place, since the duration of a flash of lightning is of the order of 1/10,000 of a second, practically the only way to secure a lightning photograph is to leave the camera open, letting the flash expose itself. In the second place, since the train is going full speed, with headlight showing, the train exposure could be obtained only with the shutter. These two conditions are obviously incompatible. The only alternative would be to secure the lucky coincidence of a flash at the instant when the train

exposure was being made, a coincidence which probably would not occur in a life-time.

This being the case, and having secured the flash photograph seen in Plate XIX., Figure 1, I decided to make the composition. I was able to secure a photograph of a train taken in broad daylight as shown in Plate XIX., Figure 2; having these photographs there remained the combining of the two so as to give the appearance of a single photograph taken at night.

For the benefit of those who would like to try photographic composition, I will try to explain as briefly as possible the way the work was done. The flash as seen in Plate XIX., measuring only about 1½ inches in length had to be enlarged to 11 x 14 inches to keep proportions with the photograph of the train, which was 8 x 10 inches. The latter, being a daylight picture, had all details showing distinctly, and in order to give it the appearance of a night photograph certain parts of it had to be reduced locally on the negative. That being done, the print from it was cut so as to leave the train and foreground, taking the sky out entirely. Then a print of the enlarged flash negative was made and the photograph of the train was adjusted and mounted on top of it. Of course, there was a considerable amount of work to be done after that, such as joining the edges so as to give it the appearance of a single photograph. It was at this stage that the difficulties began. Part of the work was done at this stage, and it was then copied and enlarged to 37 inches in length. The prints having been copied and enlarged twice, the surface of the last enlargement was very rough; it had, therefore, to be spotted until it had the appearance of a photograph enlarged from a first class original negative. It is unnecessary to give all details of the finishing touches but let me say that it was finished only after six months of hard work. Of course it was done at odd times; but even if it had been done by continuous work, it would have taken a considerable time to finish.

DOMINION OBSERVATORY,
OTTAWA, CANADA
September, 1917.

PLATE XX.

COMPOSITION PHOTOGRAPH

REVIEW OF PUBLICATIONS

The Principles of Aërography, by ALEXANDER MCADIE, A.M., S.M., Rotch Professor of Meteorology in Harvard University and Director of the Blue Hill Observatory. 8vo, 318 pages. Chicago: Rand McNally and Co., 1917. Price $3.00.

In "The Principles of Aërography" Professor McAdie has filled a want which was becoming very obvious to students of meteorology. There is, perhaps, room for doubt as to whether the term "Aërography" instead of "Meteorology" is well chosen, but the author's explanation of his reason for the change is fairly satisfactory. An outstanding feature of the work is the consistency with which all measures are given and explained in the C.G.S. units which must now be understood by all meteorologists. The use of nothing but the absolute units in text books will do much towards hastening the all-to-be desired time when they will come into general use for weather maps and bulletins issued for the information of the public generally.

In the preface Professor McAdie points out that this book contains many features not to be found in other text books. Some of these are as follows:

1. Results of recent aërological investigations.
2. Introduction of new units.
3. Cloud classification according to origin rather than appearance.
4. Studies of air flow at different levels and the gradient wind.
5. Correlation of abnormal seasons with hyperbars and infrabars.

6. Studies of ice storms, snowfall equivalents, and water supply,
7. Recent floods in the United States.
8. Charts for aviators (Rotch).
9. Variation of ocean currents.
10. Recent knowledge of solar phenomena.

In Chapter I. is given a brief but most comprehensive review of progress in upper air investigation; and a summary of the outcome of the recent numerous soundings of the upper air is given in Chapter V. The presentation of the known facts regarding the major and minor circulations of the atmosphere and also the winds is so clear, that it may well be understood by the better informed practical sailor, as well as by the meteorologist.

In Chapter IX., on forecasting storms, attention is drawn to defects in the system of classifying storms after the region where first charted. This fact was indicated very clearly when, with the extension of the Canadian réseau of stations to the Mackenzie River and Hudson Bay, it became possible to better locate the centres of low areas passing over Canada. It was found that the track of areas of the so called Alberta type was much further north than indicated by published maps of storm tracks.

The Chapters on *Atmospheric Electricity* and *Precipitation* are particularly exhaustive and the sections 47-52 on thunderstorms contain much information which has been looked for and not found in previous text books. In the Appendix are given numerous tables indispensible to persons carrying out meteorological investigation.

R. F. Stupart.

A College Text-Book of Physics, by Arthur L. Kimball, Ph.D., Professor of Physics in Amherst College. 2nd edition, revised. New York: Henry Holt and Co., 1917. Price $3.00.

Within the last fifteen years or thereabouts several comprehensive text-books on the subject of general physics have appeared in England and the United States, and this is one of the best of them. It was first published in 1911, and having

met a favorable reception, it is now issued with additions and alterations suggested by its use in class-work.

It contains 694 pages, the number allotted to each branch of the subject being as follows: Introduction, 9; Mechanics, 100; Liquids and Gases, 40; Properties of Matter and Its Internal Forces, 28; Wave Motion and Sound, 60; Heat, 82; Magnetism, 28; Electrostatics, 51; Electric Currents, 133; Light, 133; Appendices and Index, 23.

Of course the treatment is not as full as when each branch occupies a separate book, but in the space assigned to each there is a concise and clear account of its chief features. Trigonometrical ratios and also a certain amount of algebra and geometry are introduced, but for a text-book of this grade there are few mathematical symbols and formulas. Indeed, all through the work the author has followed the physical rather than the mathematical method in giving definitions and explanations.

The work is revised to date, and contains an account of researches on X-rays, the electron theory of matter and present-day wireless telegraphy and telephony. There are 623 figures in the book, which are not of the 'picture' variety but are well-made line-drawings really illustrating the subjects discussed. The paper and typography are excellent. A judicious use of black-faced type and italics impresses on the reader the most important definitions and laws, and in addition makes the printed page pleasing to the eye.

C. A. CHANT.

NOTES FROM THE METEOROLOGICAL SERVICE

Summary Report of the Weather in Canada

September, 1917

Temperature.—The mean temperature was above average in the Western Provinces and in some parts of British Columbia, the greatest departure amounting to about 5°, occurring in Northern Saskatchewan. From Lake Superior to the Maritime Provinces it was below the average, the departure varying in different localities from 1° to 5°.

Precipitation.—The rainfall was slightly above average over a portion of Southern Alberta and Southwestern Saskatchewan, while in all other parts of the Dominion it was much below the usual amount for September. Over the larger portion of the Prairie Provinces the fall was less than one inch; this was also the case in the counties bordering on the western half of Lake Ontario and over a large area lying to the northward of the Ottawa River, in Quebec. From Eastern Manitoba to the Maritime Provinces, with the exception of the above-mentioned areas in Ontario and Quebec, the fall ranged between one and two and one half inches.

Temperature for September, 1917

Station	September	
	Highest	Lowest
Yukon		
Dawson	72	18
British Columbia		
Atlin	67	30
Agassiz	83	34
Barkerville	65	22
Kamloops	87	36
New Westminster	80	44
Prince Rupert	75	40
Vancouver	79	44
Victoria	76	46
Western Provinces		
Battleford	88	29
Calgary	86	30
Edmonton	82	24
Medicine Hat	85	31
Minnedosa	91	23
Moose Jaw	92	27
Oakbank	78	28
Portage la Prairie	81	33
Prince Albert	88	26
Qu'Appelle	90	24
Regina	88	23
Saskatoon	88	26
Souris	92	25
Swift Current	90	30
Winnipeg	81	30
Ontario		
Agincourt	81	31
Aurora	77	29
Bancroft	78	23
Barrie	83	34
Beatrice	75	30
Bloomfield	77	35
Chapleau	76	14
Chatham	84	35
Clinton	77	33
Collingwood		
Cottam	82	32
Georgetown	79	33
Goderich	77	37
Grimsby		
Guelph	79	32
Haliburton	81	27
Huntsville	80	29
Kenora	82	33
Kinmount	73	25
Kingston	75	35
Kitchener	81	34
London	84	32
Lucknow	70	32
Markdale		
North Gower	80	24
Oshawa	75	41
Ottawa	80	32
Paris	85	34
Parry Sound	84	30
Peterboro'	83	32
Port Arthur	74	28
Port Burwell	74	34
Port Dover	80	34
Port Stanley	75	32
Queensborough	80	25
Ronville	76	30
Southampton	79	39
Sundridge	78	28
Stonecliffe	80	36
Stony Creek	81	34
Toronto	81	36
Uxbridge	79	31
Wallaceburg	81	34
Welland	78	34
White River	75	24
Quebec		
Brome	77	23
Father Point	66	30
Montreal	75	38
Quebec	74	30
Sherbrooke	78	31
Maritime Provinces		
Charlottetown	84	40
Chatham	82	32
Dalhousie		
Fredericton	82	29
Halifax	74	34
Moncton	80	30
St. John	78	35
Sussex	76	30
Sydney	84	38
Yarmouth	70	32

Earthquake Records by the Milne Seismograph

TORONTO

Sir Frederic Stupart, Director.

P.T. = Preliminary Tremors, S. = Secondary Waves. L.W. = Large Waves. A.C. = Air Currents. Time is Greenwich Civil Mean Time, 0 or 24 h = midnight.

No.	Date 1917	P. T. Comm.	S. Comm.	L.W. Comm.	Max.	End	Max. Amp.	Remarks
		h m	h m	h m	h m	h m	mm	
1766	Sept. 18	22 4·5?		22 20·8) 22 26·1)	22 33·8	23 11·9	0·3	P. doubtful.
1767	" 20			3 54·9) 3 57·0)	4 00·4	5 16·7?	1·2	
1768	" 24			20 34·5) 20 35·7)				A. C. going on.

Boom period 18 seconds. Pillar inclination 1mm. = 0″·50.

VICTORIA, B. C.

F. N. Denison, Superintendent.

No.	Date 1917	P.T. Comm.	S. Comm.	L.W. Comm.	Max.	End	Max. Amp.	Remarks
		h m s	h m s	h m s	h m s	h m s	mm	
1779	Sept. 18		22 11 32?				0·05	
1780	" 20		3 33 17	3 38 15	3 45 41	4 03 31	0·4	
1781	" 24	20 30 06?	20 41 01?	20 50 56	21 02 20	21 19 02	0·3	

Boom period 18 seconds. Pillar inclination 1mm. = 0″·54

MAGNETIC OBSERVATIONS

JULY-AUGUST, 1917

Moderately large disturbances were recorded on July 13, 28, 29 and 31, but generally during the month of July the magnets were quiet.

The month of August was a particularly disturbed one. Only on August 3, 5, 6 and 28, are the curves classified as calm. Large disturbances occurred August 13 to 15, 22, 23, 25 and 26, and very great disturbances August 8, 9 and August 20, 21. The curves of these two great disturbances are being reproduced in the present number of the JOURNAL. The declination Curves at Meanook are very much more disturbed than those at Agincourt.

The differential Declinometer at Meanook was dismounted on August 21, at 11 o'clock for the purpose of installing a slate base. The remounting was completed and the instrument again in operation at 8 p.m. August 27.

Large groups of sunspots were visible both north and south of the sun's equator during July and August.

Very few auroræ were recorded by meteorological observers in Canada during July, but very many were recorded throughout the month of August. On the 8, 14 and 21 they were particularly brilliant.

Observations were made for Horizontal Force at Meanook on August 30, 31 and September 4, with the following results.

1917	105th M.T.		H
	h	m	γ
August 30	14	55	12936
August 31	11	17	12892
September 4	10	47	12896
		Mean	12908

AGINCOURT MAGNETIC OBSERVATIONS

Lat. 43° 47′ N.; Long. 79° 16′ W.

July, 1917		D. West	H	Z	I
		° ′	γ	γ	° ′
	Mean of Month	6 35·4	15954	58422	74 43·6
	Maximum	6 59·2	16051	58596	
	Date of Maximum	31	27	31	
	Minimum	6 12·2	15825	58298	
	Date of Minimum	28	31	13	
	Monthly Range	0 47·0	226	298	
Mean Daily Amplitude	From hourly readings	14·5	52	26	
	From means of extremes	21·6	90	54	

August, 1917		D. West	H	Z	I
		° ′	γ	γ	° ′
	Mean of Month	6 36·5	15931	58441	74 45·1
	Maximum	*8 48·7	*10414	58753	
	Date of Maximum	9	9	9	
	Minimum	5 26·2	*15427	*57517	
	Date of Minimum	9	9	9	
	Monthly Range	3 22·5	987	1236	
Mean Daily Amplitude	From hourly readings	17·1	97	51	
	From means of extremes	41·0	198	147	

* Beyond limit of photographic paper. Value estimated.

H and Z are given in Gammas. (1 γ = 0·00001 C.G.S.).

All results are reduced to I.M.S.

D = Declination; H = Horizontal Force; Z = Vertical Force; I = Dip or Inclination.

MEANOOK MAGNETIC OBSERVATIONS

Lat. 54° 37′ N.; Long. 113° 21′ W.

July, 1917		D. East	I
		° ′	° ′
	Mean of Month	27 45·3	77 53·9
	Maximum	*29 41·0	
	Date	31	
	Minimum	25 40·4	
	Date	28	
	Monthly Range	4 00·6	
Mean Daily Amplitude	From hourly readings	21·5	
	From means of extremes	46·2	

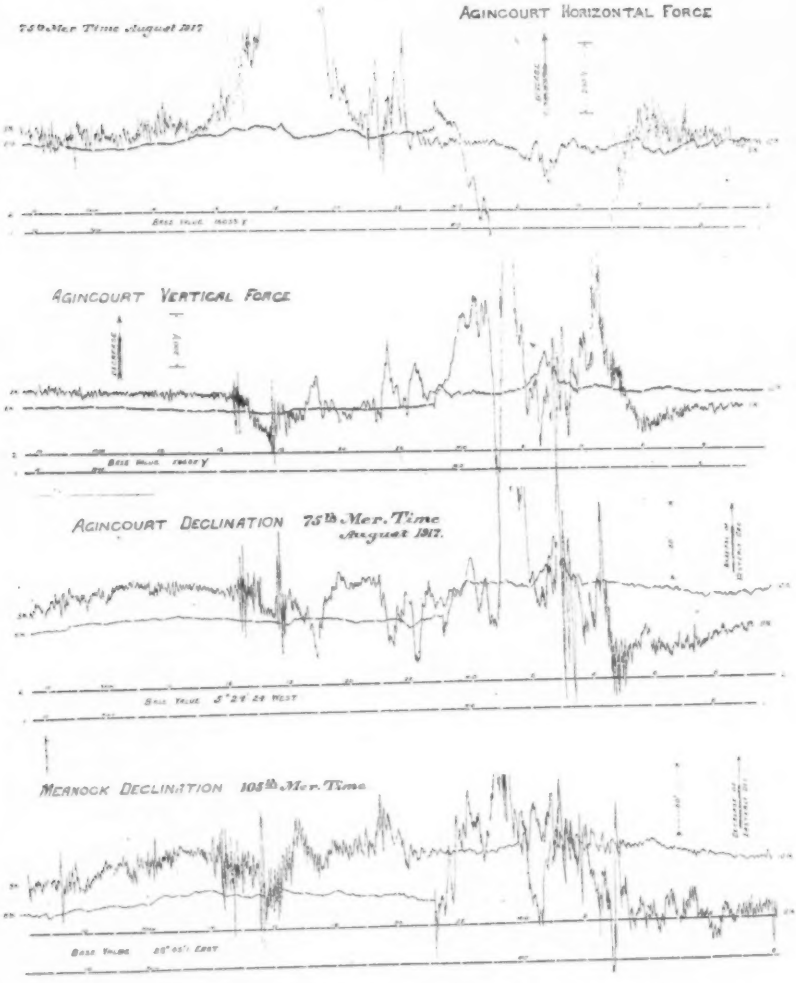
August, 1917		D. East	I
		° ′	° ′
	Mean of Month	27 45·5	77 54·1
	Maximum	*29 57·5	
	Date of Maximum	14	
	Minimum	*25 16·1	
	Date of Minimum	8	
	Monthly Range	4 41·4	
Mean Daily Amplitude	From hourly readings	19·9	
	From means of extremes	1 18·6	

*Beyond limit of photographic paper. Value estimated.

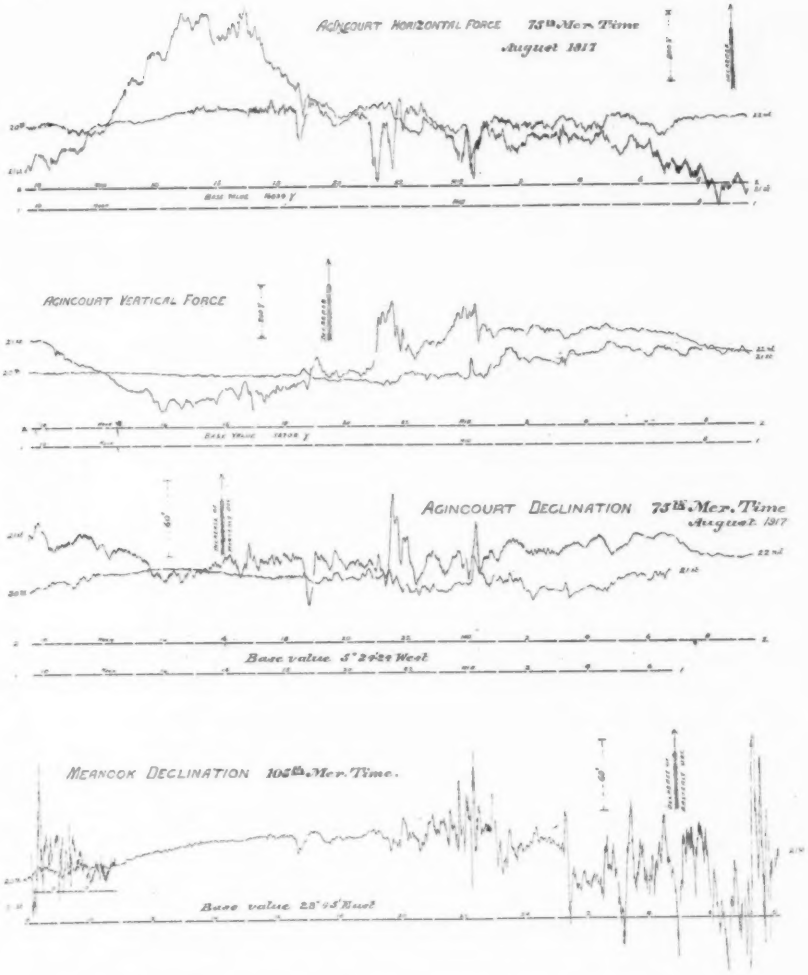
The value for I is the mean of all the observations made during the month without regard to the time of day.

All results are reduced to International Magnetic Standard.

W. E. W. J.


AGINCOURT HORIZONTAL FORCE
AGINCOURT VERTICAL FORCE
AGINCOURT DECLINATION 75th Mer. Time August 1917.
MEANOOK DECLINATION 105th Mer. Time

PHOTOGRAPHIC RECORDS AT AGINCOURT AND MEANOOK OF THE MAGNETIC STORM OF AUGUST 8 AND 9, 1917.


AGINCOURT HORIZONTAL FORCE 75th Mer. Time
August 1917
AGINCOURT VERTICAL FORCE
AGINCOURT DECLINATION 75th Mer. Time
August 1917
Base value 5° 24·2 West
MEANOOK DECLINATION 105th Mer. Time.
Base value 28° 45' East

PHOTOGRAPHIC RECORDS AT AGINCOURT AND MEANOOK OF THE MAGNETIC STORM OF AUGUST 20 AND 21, 1917

ASTRONOMICAL NOTES

A STUDY OF CERTAIN NEBULÆ.—The nebulæ are a weak link in every chain of stellar evolution thus far forged. Some hypotheses place them before the stars, while others consider them as the latest stage of development. Detailed studies of their present forms and the physical conditions under which they now exist are a pressing need.

Of the several classes of nebulæ, the planetary nebulæ seem to be the most promising for a detailed investigation. They are in general small and bright, have fairly definite forms in space and give bright-line spectra. The extended nebulæ seem to have no definite form. The spiral nebulæ are quite faint, and suitable spectrograms are very difficult to obtain.

The planetary nebulæ *N.G.C.* 6543 and *N.G.C.* 7009 have been chosen as the subjects of the present investigation. Up to about two years ago the work on these two objects had been of a very general nature. Holden and Schaeberle made careful drawings of them with the 36-inch refractor. These interesting visual observations are of limited value in comparison with existing photographic results.

* * * * * * *

Both the spectrographic and photometric study of these two nebulæ along the minor axes seem to point to a rotating ellipsoidal shell as a possible form. Along the major axes this theory seems to fail in both cases. In both nebulæ there are faint ansæ extending out beyond the main nebula in directions

approximating those of the major axes. It is possible that if the shell were not in rotation the attractive forces from a condensed nucleus might counter-balance the repulsive forces (light pressure, diffusion of the gas, etc.) in such a manner as to hold the shell in equilibrium. As the shell rotated this equilibrium would be destroyed, and the material might be driven out along the lines perpendicular to the axis of rotation. The researches of Darwin, Jeans, and others referred to above have dealt with problems of this sort, but their results are not conclusive as to just what the final figure would be. An effect of this kind might account for the failure of the photometric curves to fit the intensity curves produced by any simple geometrical theory, but it would offer no explanation of the apparent reversal of direction of rotation at the outer ends of the major axes.

An attempt has been made to account for this reversal on the hypothesis that the nebulæ are made up of various shells of gases, rotating in different directions and each about its own axis. The axes of the various shells may not coincide. On this hypothesis we shall consider the result if the main body of the nebula were an ellipsoidal shell and that this is encircled in the plane of the major axis by a shell of material rotating in the opposite direction. If we further assume that the eccentricities of this shell are greater than those of the main ellipsoid and that it is intrinsically considerably fainter, any effect of its velocity would be masked in the region where we are viewing the main body through it. When we passed out beyond the edge of the main ellipsoid the velocity of the belt would become effective and the line would suddenly "hook back" in the reversed direction from the slope it had maintained up to this point. This is very similar to the effect observed in the direction of the ansæ in *N.G.C.* 7009. In *N.G.C.* 6543 this effect is also evident, but to a lesser degree, and it seems to persist over a larger area in the nebula. This might be explained on the hypothesis that the principal plane of the encircling shell is inclined to the line of sight. The possible inclination is further supported by the appearance of the ansæ which, instead of being sharp as in

N.G.C. 7009, are rounded. The abnormal velocities in the outer portions of the nebulæ proper might be explained by other bands of material with their axes shorter than those in corresponding directions in the main ellipsoidal shell. Such bands might produce the brighter spots appearing in the shorter exposure-time photographs.

The hypothesis of an ellipsoidal shell with rotating rings of material might also explain some of the irregularities in the photometric curve.

It is difficult to understand how any such system of construction for nebulæ could come into existence, or to predict its future development. It would undoubtedly be in unstable equilibrium and it is possible that the two nebulæ, of different types in the Harvard Classification of Nebulæ, represent different stages of development. There is also the possibility that the points of peculiar brightness and velocity may be produced by abnormal pressures, temperatures or other physical qualities of the gas itself. In the present state of our knowledge of the effects of such conditions on the wave-length of the produced radiation it is futile to attempt any hypothesis on these grounds.

This hypothesis for the construction of nebulæ, namely, a foundation of a rotating ellipsoidal shell, together with secondary bands or shells rotating about various axes, is far from definite or conclusive. It is advanced as the only apparent explanation of the relative velocities and brightnesses existing in the planetary nebulæ *N.G.C.* 6543 and *N.G.C.* 7009.—W. K. Green, in *Lick Observatory Bulletin*, No. 298.

Faint Star with Large Proper Motion near α Centauri.—Professor Frank Schlesinger, Director of the Allegheny Observatory, furnishes the following note drawn from a private letter from Dr. Voute.

Dr. Voute is a Dutch astronomer temporarily located at the Cape Observatory where he is making parallax determinations with the transit circle and also with the Astrographic Telescope. One of the objects on his observing program is a faint star

(visual magnitude 11·0) that was found to have a very large proper motion by the observers at the Union Observatory at Johannesburg. Dr. Voute finds that this star has practically the same proper motion as α Centauri, from which it is distant 2° 13′, and his determination of the parallax yields 0″·755, which is also very nearly equal to that of α Centauri. The photographic magnitude of the star is only 13·5 so that it must be a red star. Intrinsically it is by far the faintest star yet discovered.—*Popular Astronomy*, No. 8.

ASTRONOMY AND THE WAR.—The world-wide conflict which is to-day absorbing the energies of so many nations has not been able to withhold may scientists from continuing investigations of a purely speculative nature. So it has come about that during the past year astronomical activity has not sensibly slackened. As Professor Sampson has pointed out, many examples might be cited of important developments in astronomy occurring during the most disturbed periods in history. Newton's immortal *Principia* appeared during the great revolution in England; Hevelius and Gassendi exchanged their scientific correspondence at a time when all Europe was turned upside down; Kepler discovered his laws of the movements of the planets during the great Thirty Years' War; Laplace published his great work, the "Mécanique Céleste" in the midst of the French Revolution; Gauss quietly pursued his mathematical studies at a time when the army of Napoleon was invading Germany, and, finally, to come nearer home, the American Astronomer Newcomb and Delaunay, the director of our national observatory, worked together in that observatory at the lunar theory whilst the Commune was terrorising the capital. We shall now see how, even to-day, the disturbance which the war has caused in our lives is far from having brought about a cessation of astronomical investigation.—From Presidential Address, Société Astronomique de France, by COUNT DE LA BAUME PLUVINEL, *Observatory*, No. 517.

J. R. C.

NOTES AND QUERIES

Communications are Invited, Especially from Amateurs. The Editor will try to Secure Answers to Queries.

THE AURORAL DISPLAY OF AUGUST 21, 1917

In the present number (p. 365) Mr. A. Steadworthy gives a description of this display as seen by him in Algonquin Park, and three fine drawings made by him are reproduced. As noted in the September number (p. 315) the display was seen by the present writer on the shore of Georgian Bay, in latitude 45° N. It may be well to remark that Mr. Steadworthy's third sketch (Plate XVI.) is an instantaneous representation of the phenomenon. As a matter of fact the bright patches or 'clouds' were in rapid motion upwards, in many cases going beyond the zenith.

During the display an attempt was made to locate the focus of the streamers. At 9.57 p.m. (E.S.T.) it was estimated to be at β Cygni. By calculation I find this point was then in azimuth 6° 51′ west of south and altitude 72° 41′.

On page 391 Mr. W. E. Jackson gives an account of the two great magnetic storms in August, the motion of the needles being illustrated by two engravings. From him I learn that the mean value of the elements when I estimated the position of the focus were :

	Dip	Declination
For Agincourt	74° 49′	6° 43′ W. of N.
For Muskoba	75° 49′	7° 13′ W. of N.

In other words the magnetic zenith, that is, the point in the sky to which the dipping needle pointed, was in azimuth 7° 13′ east of south and in altitude 75° 49′. Calculation shows that this was 4° 55′ from the estimated position of the focus of the streamers.

Of course the estimate of the position of the focus was only a rough approximation, and it may be that it actually coincided with the magnetic zenith. Reference may be made to pages 16 and 134 of this volume of the JOURNAL, where are given comparisons of the position of the focus of the aurora of August 26, 1916, relative to the magnetic zenith.

ASTRONOMY IN NEW ZEALAND

I fear that most Canadians possess only meagre information regarding the island Dominion of New Zealand, which is almost at our antipodes, but in these trying times Britishers all over the earth are united in a strong bond of sympathy. The area of New Zealand is rather larger than twice that of New York State and its population is over a million. The report of Government Astronomer C. E. Adams, dated June 20, 1917, deals chiefly with the usual routine matters of an observatory, but several items are of special interest.

The establishment of a wireless time service for New Zealand has been strongly urged and an aerial has been erected at the Observatory. It is hoped that a complete equipment will soon be forthcoming. At Awanui, which is on the north end of North Island, is a government radio-station, and the Governor of Tahiti requested that wireless time signals be sent from it to Papeete, 2700 miles to the north-east, in order to determine the longitude of the latter place. Accordingly signals were sent from the standard clock of the Observatory by the land lines of the Telegraph Department to Awanui, where they automatically operated the key of the radio-station and were transmitted by wireless to Papeete. Mr. H. F. Johnston, an officer of the Department of Research in Terrestrial Magnetism of the Carnegie Institution of Washington, was at the time (June 30, 1916) in Tahiti and he offered to receive the signals and also, by means of a theodolite, to observe for local time. In this way the longitude of Pt. Venus was determined to be 149° 30′ 01″ W., which is 46″ or 3ˢ greater than the value usually quoted. Mr. Johnston, by

the way, formerly lived at Kippen, in Huron County, Ontario, and graduated with distinction from the University of Toronto in 1910. Immediately he was given a position in the Department of Research in Terrestrial Magnetism and remained there until early in the present year, when he resigned in order to enlist in the Officers Training Corps at the University of Toronto. However, when the Admiralty learned of his special training, he was transferred to its Compass Department. Knowing Mr. Johnston, I am not surprised at his willingness to undertake the service at Tahiti. Indeed, I could give personal testimony to the courtesy of the Department of Research in Terrestrial Magnetism on other occasions.

New Zealand also has its time problem. The Dominion now has as its standard time that for the meridian 172° 30′ east, which is $11^h\ 30^m$ in advance of Greenwich Time. This time was adopted in 1868. It is now proposed to make the time exactly 12^h in advance of Greenwich. A Committee of the Council of the Wellington Philosophical Society gives the following reasons for the change: (1) Direct saving in all lighting of half an hour daily, as well as a saving in capital expenditure on plant and machinery. (2) Conformity with International Time agreement, for exact hours different from Greenwich. (3) Ease of conversion of times between New Zealand, United Kingdom and other countries, with less liability of error. (4) Method already in practical use at the Hector Observatory, Wellington. (5) Precedents of (*a*) South Africa, (*b*) Ireland. (6) Whole of North Island and part of South Island are slow on New Zealand time. Alteration would bring New Zealand into line with the United Kingdom. (7) Direct benefits to the individual in reduction of period of using artificial light in the workshop, office and home. One would think these sufficient to cause any government to act, but so far nothing has been done.

I notice also that it is a part of the policy of the Minister of Internal Affairs, who is in charge of the Observatory, to have lectures on astronomical subjects delivered at various points. Already these have borne fruit in the advance of astronomy.

C. A. C.

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